Instructions for calculating hydromorphological indices values using River Habitat Survey data.

Hydromorphological indices

A series of 6 indices representing habitat dimensions were derived using River Habitat Survey spot-check data and a multi-variate statistical analysis called Correspondence Analysis (Naura 2014; Naura *et al.* submitted).

The indices represent channel substrate size, flow regime, channel vegetation structure, geomorphic activity and bank vegetation. Index values are calculated using a simple equation applied to feature occurrence (e.g. substrate types) from RHS spot-check data.

Calculation can be performed using the 'RHS Hydromorphological Indices Calculation' Excel spreadsheet or by hand using the equations below. The table below shows how one of the indices, the Channel Substrate Index is calculated for a given RHS site.

Substrate	Coefficient (Coeff)	**Occurrence of substrate types at the site across 10 spot-checks (Occ)**	**Coeff x Occ**
Bedrock/Artificial	0.89	**0**	**0**
Boulder	0.95	**0**	**0**
Cobble	0.58	**3**	**1.74**
Gravel-pebble	-0.60	**6**	**-3.6**
Sand	-1.63	**0**	**0**
Silt	-2.33	**1**	**-2.33**
Clay	-2.28	**0**	**0**
Peat	+0.08	**0**	**0**
		Total for site	**-4.19**
		Average for site = Total/nb of spot-checks with no missing values	**-0.419**
The overall substrate index score for the site is -0.419			

Channel Substrate Index

The **Channel Substrate Index (CSI)** is calculated as follow:

CSI = (0.89(AR+BE) +0.95 BO + 0.58 CO + 0.08 PE - 0.6 GP - 1.63 SA – 2.33 SI – 2.28 CL) / Nsc

where each two-letter acronym refers to the following RHS channel substrate categories (in order of appearance): artificial, bedrock, boulder, cobble, peat, gravel-pebble, sand, silt and clay; and Nsc is the total number of spot-checks.

Geomorphic Activity Index

The **Geomorphic Activity Index (GAI)** was derived using the occurrence of erosion deposition features across 30 potential spot-checks and the number of riffles and pools. Sites with an excessive

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number of riffles or pools (i.e. 20 riffles or pools per 500m section) were set to 20.

The GAI is calculated as follow:

GAI = (1.32 EC + 0.6 SC - 0.02 VB + 1.33 UB + 0.72 RO + 1.33 Riffles + 1.64 Pools – 0.83 NO) / Nsu

where each two-letter acronym refers to the following RHS bank and channel features (in order of appearance): eroding cliffs, stable cliffs, vegetated bars (point bars + side bars + mid-channel bars); unvegetated bars (point bars + side bars + mid-channel bars); exposed boulders, number of riffles, number of pools and number of spot-checks with no features present. Nsu is the total number of survey units calculated as EC+SC+VB+UB+RO+NO+Riffles+Pools.

Flow Regime Index

The **Flow Regime Index (FRI)** was derived using the occurrence of flow-types at 10 spot-checks. The FRI is calculated using the equation:

FRI = (2.02 FF + 1.5 CH + 1.43 CF + 1.48 BW + 0.61 UW + 1.41 UP + 0.45 RP - 1.2(SM + NP) / Nsc

where each two-letter acronym refers to the following RHS channel flow-type categories (in order of appearance): freefall, chute, chaotic flow, broken standing waves, unbroken standing waves, upwellings, rippled flow, smooth flow and no perceptible flow. Nsc is the total number of spot-checks.

Channel Vegetation Index

The **Channel Vegetation Index (CVI)** was derived using the occurrence of channel vegetation at spot-checks. All data were converted to presence/absence. The absence of vegetation at spot-checks was recoded as a single **binary** variable ($None_b$). The variable was set to 1 if 'None' was ticked at any of 10 spot-checks. Submerged fine and linear leaved categories were combined into a single category based on the presence of either plant type.

CVI = (0.71 $None_b$ - 0.39121 Amphibious - 0.82 Herbs emergent - 0.90 Reeds emergent + 0.55 Filamentous - 1.74725 Floating rooted - 2.07 Free floating + 1.2 Bryophytes mosses lichens - 1.29 Submerged broadleaved - 1.09 Submerged fine and linear leaved)/ Nsu

where each categories refers to the number of spot-checks a channel vegetation type was recorded as **present or extensive**. Nsu is the total number of survey units calculated as $None_b$+amphibious+herbs emergent+reeds emergent+filamentous+floating rooted+free floating+ bryophytes mosses lichens +submerged broadleaved+submerged fine and linear leaved.

Banktop vegetation index

The **Banktop vegetation index (BTV)** was derived using the occurrence of each bank top vegetation structure categories at 10 spot-checks on the left and right banks.

BTV = (-0.33 B - 1.27 U + 0.48 S + 1.43 C)/ Nsu

where each category acronym refers to Bare, Uniform, Simple, Complex and Nsc is the total number of survey units (max = 20 for 2 banks).

Bank face vegetation index

The **Bankface vegetation index (BFV)** was derived using the occurrence of each bank face vegetation structure categories at 10 spot-checks on the left and right banks.

BFV = (-0.87 B - 1.18 U + 0.36 S + 1.87 C)/ Nsu

where each category acronym refers to Bare, Uniform, Simple, Complex and Nsc is the total number of survey units (max = 20 for 2 banks).

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Morphological indices indicative score bands

Bands are indicative only and should be adapted to local context.

Channel Substrate Index:
Silt < - 1.81
Sand/Silt/Clay - 1.82 to - 1.17
Gravel/Pebble -1. 17 to -0.1
Cobbles -0.1 to +0.63
Boulder/Bedrock > +0.63

Flow Regime Index:
Step-pool <- 1.59
Cascades -1.59, -1.24
Rapids-1.24, -0.86
Riffles,runs -0.86, -0.22
Run, glide -0.22, 0.42
Glide, pool > 0.42

Channel Vegetation Index:
Floating < -1.23
Emergent-Submerged -1.23, -0.44
Emergent-Filamentous Algae -0.44, 0.26
Mosses-filamentous algae 0.26

Geomorphic Activity Index:
no activity < -0.79
very low activity -0.79, -0.66
low activity -0.66, -0.45
moderate activity -0.45, -0.12
high activity -0.12, 0.33
very high activity > 0.33

Bank Top Vegetation:
Uniform < -0.26
Simple -0.26 - 0.77
Complex > 0.77

Bank Face Vegetation:
Bare/Uniform < -0.51
Simple -0.51 - 0.9
Complex > 0.9

References

Naura, M. (2014) *Decisions Support Systems. Factors affecting their design and implementation within organisations. Lessons from two case studies.* Lambert Academic Publishing, Berlin.

Naura, M., Clark, M.J., Sear, D.A., Atkinson, P.M., Hornby, D.D., Kemp, P., England, G., Peirson, G., Bromley, C. & Carter, M.G. (submitted) Mapping habitat indices across river networks using regression kriging and semi-quantitative data: an example applied to channel substrate in English and Welsh rivers. *Ecological Indicators*.

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